Appendix I

Sediment Analysis of Civa II and Slivovitz Rock Shelters

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Introduction

Sediments from Civa II and Slivovitz Rock Shelters were examined in order to distinguish visible strata and to draw inferences about the depositional history of the two sites. Additional study of soils outside the shelters and a sample of a lacustrine sediment from Coal Valley Dry Lake provided some basis of comparison of cultural and natural deposits. Information gathered from the determination of particle size distribution, color, presence or absence of free carbonates, % loss on ignition, pH, and % total phosphorous plus a cursory mineralogical analysis served to characterize the sediments.

Methods

Site study of the soils and sediments were precluded due to a lack of time. Other tests (e.g., calcium, organic carbon) which could have yielded additional information were not carried out for the same reason. A more systematized procedure for field sampling of the deposits would have provided for more valid results but this was not possible due to field conditions. The tests that were carried out gave consistent results and independently confirmed field observations (e.g., the aeolian deposit in Slivovitz Shelter).

All samples were allowed to reach air dry condition before sieving through a 2 mm sieve. Percent by weight of $>$ 2 mm fractions was determined. The water content (Pw) of the $<$ 2 mm fractions was determined and a few grams of each sample were crushed with the Spex Mixer/Mill for the phosphorus and % loss by ignition analyses. Phosphorus was extracted by digestion with perchloric acid and determined by standard colorimeter methods. Percent loss by ignition was found by recording weight loss of samples (beyond Pw) placed in 450^{o} C oven for 1.5 hours. Color was determined on dry and moist sampled under natural lighting according to the Munsell Soil Color Charts. A few drops of 10% HCl solution were placed on samples to check for presence and degree of free carbonates (cf. USDA Soil Manual 1951). pH was determined by the saturation paste method withthe Beckman Zeromatic pH Meter. Textual analysis of the $<$ 2 mm fraction was done by the hydrometer method (Day 1965: 562-566). Samples of the clay fraction for X-ray diffraction were taken from the suspended load after a 2 hour settling period. The sand fractions were initially retained by wet sieving (0.05 mm sieve) and then separated by dry sieving.

Discussion

I. Lithology and External Soils

Both rock shelters are included in the Younger Volcanic Rocks unit (Tertiary) described in Tschanz and Pampeyan (1970). The rocks of Civa II are made up of devitrified welded ignimbrite which contains "...up to 50% broken crystal fragments of quartz, potash feldspar, plagioclase, biotite and hornblende, and a few foreign rock fragments" (Tschanz and Pampeyan 1970: 73). Slivovitz consists of partially devitrified obsidian with what looks to be a small percentage of quartz and feldspar crystals. Based on the excavator's description (Busby, personal communication, 1977) and lab analysis, the soils just outside the sites are shallow (about 5 cm to paralithic contact) and residual, with little profile development. Periodic erosion (slipes are 5-10% outside the rock shelters), a fairly resistant bedrock, and the generally arid climate probably all contribute to the shallowness and general lack of development of the soils. Interestingly, the soil outside Civa II is calcareous and light colored, in contrast to the soil outside Slivovitz which is non-calcareous and much darker in color (Table 1). The soil outside Slivovitz also has a higher % of total phosphorus that expected (cf. Cook and Heizer 1965: 22-23) and is associated with higher organic matter content there. Grazing animals may be contributing to this high organic matter content.

Civa II is located at a lower elevation, ca. 5800 feet (1768 m), in a much more arid area with sparse desert vegetation (see Natural Setting chapter), whereas Slivovitz is located in forested canyon at about 7000 feet (2134 m). Moister conditions and higher amounts of organic matter have made for a distinctive A1 horizon outside of Slivovitz directly overlying bedrock.

2. Rock Shelter Deposits

The primary source of sediment, about 80 cm thick in both rock shelters, is the breakdown of the enclosing bedrock. A comparison of the sand fractions (Table 1, Fig. 2) shows the general similarity of most of the cave strata with the weathered bedrock (Civa II) and external soils. Fragments of bedrock ranging from gravel (numerous) through boulder (few) size have been found in most levels. The mechanical and chemical weathering of the fallen rock partially accounts for the finer textures in most of the strata as compared to the weathered bedrock and external soils. The variable addition of wind-blown fine sands, silts and clays also contributes to the finer textures of the rockshelter sediments. Similar findings on the origins of prehistoric rockshelter sediments are described in other studies (Butzer 1971, Farrand 1975). Special aspects of the deposits are discussed in the context of each rockshelter.

A. Civa Shelter II

Although no pattern is apparent in the strata of Civa II some special deposits are noted. A higher level of occupation (subsistence related??) is suggested in Stratum B_2 by the high carbonate (calcium) content, accompanying higher pH, and higher percentage of total phosphorus (Table 1). Analysis of discrete clay deposits reveal that they are likely to have been culturally introduced to the shelter. X-ray diffraction shows one clay sample to be pure montmorillonite in contrast to the clay fractions analyzed from a continuous stratum (Level B) which includes quartz, feldspar, mica and calcite as well as montmorillonite. The main clay deposit is the only non-calcareous deposit in the shelter and contains little phosphorus (Table 1). It seems impossible for such a pure clay to be altered from a volcanic rock low in bases, especially in a short time. The sand fraction in the clay deposit is much coarser than in the other shelter strata and may have been deliberately mixed with the clay as a tempering material for pottery manufacture. This sand fraction does show the same bimodality in size as the other deposits, external soil, and weathered bedrock. One problem in speculating that the clay was used for ceramics is that montmorillonite is a poor choice of clay because of its tendency to shrink and swell upon drying and wetting.

B. Slivovitz Shelter

Slivovitz Shelter's deposits provide a clearer picture of depositional history than do the Civa II sediments, mainly because of Stratum B, which is primarily aeolian in origin. This is shown in the preponderance of silt and very fine sands (Table 1, Figs. 1 and 2) which are the size classes most readily transported by wind (Brady 1974). The $>$ 2 mm fraction drops off considerably in Stratum B as well. A brief look at the mineralogy of the silt fraction by Dr. Richard Hay, Department of Geology, University of California, Berkeley (Hay, personal communication, 1977) revealed two factors diagnostic of aeolian activity: 5-10% volcanic glass shards and opal phytoliths which are inorganic biogenetic plant particles (cf. Rovner 1971). An unknown percentage of the opal phytoliths have probably been derived from plants brought into the shelter by the occupants. Both of these are found in the silt fraction of the Coal Valley Dry Lake sediment sample which is a likely source for the aeolian material. Actually, all of the natural strata of both rock shelters have an aeolian component but only in Stratum B of Slivovitz does it predominate.

The overall siltier textures of the Slivovitz deposits (Table 1, Fig. 1) suggest they have been more exposed to prevailing winds and aeolian deposition. It was observed during excavation that swirling winds inside the shelter are active in certain areas and not in others. This probably accounts for the variation in thickness of Stratum B (Busby, personal communication, 1977).

A lower percentage of total phosphorus and lower organic matter content (roughly given by % loss on ignition) in the primarily aeolian deposit (Stratum B), compared to Stratum A above it and Stratum C below it, appears to indicate a less intense level of cultural activity. What is suggested is a drought (increased aeolian activity with dessication ofthe Coal Valley Dry Lake) during which hunting and other subsistence activities declined. Stratum B may even represent a period of abandonment or extreme disuse if the artifacts recovered from Stratum B are assumed to be intrusive from later occupation. Considering the thickness of Stratum B (5-10 cm and discontinuous over the surface) this may be a valid possibility.

As a final note, the Slivovitz deposits have been subjected to leaching as shown by the pH profile in Fig. 3 and the relative amounts of carbonates in Table 1. This supports the hypothesis that Slivovitz has been more exposed to outside climatic conditions than Civa II. The phosphorus profile has more or less retained its original form because phosphorus is immobilized in the form of calcium phosphates at the pH range of the deposits (Table 1 and Fig. 3). Also, phosphorus levels are higher at Slivovitz (except for Stratum B) than at Civa II, possibly indicating a higher level of subsistence activities (esp. hunting related activities) at this shelter.

Acknowledgement

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TABLE 1 - Civa II and Slivovitz Rockshelters: Sediment Data

Sample	Organic Matter %Loss Ignition	%Sand	%Silt	%Clay	Texture	Sand Fractions - % of Sand Total: Very Coarse	Coarse	Medium	Fine	Very Fine	Pw	% > 2mm Wt.	Dry Color	Moist Color	Carbonation R x Nw/HCl	pH	Total P % of soil
Slivovitz																	
Stratum A (upper)	22.70	37.4	45.2	17.4	gravelly loam	14.7	24.9	14.0	21.3	25.1	6.92	30.1	10YR4/2	10YR2/2	+ e	7.0	0.37
Stratum A (lower)	21.16	32.6	45.6	21.8	"	13.2	25.3	14.1	21.7	25.7	9.14	21.5	10YR4/2	10YR2/2	+ e	7.8	0.60
Stratum B	1.35	22.8	57.7	19.5	silt loam	3.0	6.1	3.9	16.9	70.2	4.07	5.2	10YR6/3	10YR3/3	+ e	8.3	0.11
Stratum C	4.87	44.5	38.9	16.6	very gravelly loam	14.7	27.4	13.6	21.0	23.2	5.31	38.2	10YR4/1	10YR2/1	+ es	8.3	0.29
Ash Layer	0.77	49.6	37.2	13.2	gravelly loam	12.0	30.0	14.1	22.3	24.7	1.87	30.1	10YR6/2	10YR3.5/3	+ es	8.7	0.24
Civa II																	
Stratum A (N8E0, N)	2.88	36.7	30.9	32.4	clay loam	6.1	22.9	15.0	30.6	25.3	6.10	8.6	10YR6/2	10YR3/2	+ es	7.7	0.16
Stratum A (N8E0, E)	2.34	41.7	36.3	22.0	loam	5.7	18.2	13.8	31.1	31.3	3.40	14.5	10YR6/2	10YR3/3	+ e	7.8	0.16
Stratum B (N8E0, N)	1.98	41.7	22.4	35.9	gravelly clay loam	8.9	26.4	16.0	28.9	19.9	6.41	16.6	10YR6/2	10YR3/2	+ e	7.6	0.18
Stratum B (N8E0, E)	2.84	47.9	38.6	13.5	loam	11.3	18.3	12.5	29.3	28.7	3.53	9.7	10YR4.5/2	10YR2/2	+ es	7.7	0.22
Stratum B$_1$ (N8E0, N)	3.19	35.5	16.3	48.2	gravelly clay	15.9	28.9	16.1	24.6	14.5	10.12	20.4	10YR5/1	10YR4/2	+ e	7.4	0.05
Stratum B$_2$ (N8E0, E)	0.35	45.7	38.6	15.7	loam	4.4	17.9	13.8	33.3	30.7	4.66	4.9	10YR6/1	10YR4/2	+ ev	8.3	0.30
Stratum C^2 (N8E0, E)	3.66	44.3	28.8	26.9	gravelly heavy loam	13.8	23.5	14.7	27.4	20.6	6.53	18.2	10YR6/1	10YR3.5/1	+ es	7.6	0.15
Stratum D (N8E0, N)	5.23	41.5	32.6	25.9	loam	10.5	23.6	15.8	28.8	21.4	6.82	7.7	10YR5/1	10YR2/1	+ es	7.7	0.19
Stratum D (N8E0, E)	2.66	49.9	34.3	15.8	light loam	10.3	20.4	14.4	29.4	25.5	5.06	7.8	10YR5/1	10YR3/1	+ es	7.9	0.18
Stratum E (N8E0, E)	2.64	44.1	26.9	29.0	clay loam	13.1	24.0	15.2	27.9	19.7	7.44	13.4	10YR5.5/1	10YR3/1	+ e - es	7.7	0.12
Stratum F (N8E0, E)	3.60	46.9	36.1	17.0	loam	10.5	19.5	13.4	29.7	26.8	4.44	10.5	10YR5.5/1	10YR3/1	+ es	7.9	0.20
Stratum G (N8E0, N)	3.85	55.4	31.6	13.0	gravelly sandy loam	12.5	21.2	14.7	29.6	22.1	3.90	18.0	10YR5/1	10YR3/1	+ es	7.9	0.19
Stratum N (N8E2, E)	3.12	47.0	34.3	18.7	loam	10.9	20.5	14.3	29.4	24.8	5.33	10.1	10YR5/1	10YR3/1	+ es	7.9	0.20
Ash - N8E0	2.10	55.1	25.9	19.0	sandy loam	8.0	18.8	15.5	34.5	23.3	4.22	4.8	10YR8/2	10YR6/2	+ es	7.9	0.03
Clay Deposit	0.41	41.4	14.3	44.3	clay	14.5	28.7	16.6	24.1	16.1	8.75	2.2	10YR6/2	10YR3/1	-	7.2	0.02
Weathered Contact Bedrock	0.78	64.9	26.9	8.2	"sandy loam"	9.6	17.5	14.8	34.2	24.0	5.72	-	10YR8/1	10YR6/2	-	7.5	0.02
Outside Soil - Layer 1	1.55	55.7	31.2	13.1	gravelly sandy loam	15.6	18.1	12.9	27.8	25.6	2.39	28.6	10YR6.5/3	10YR4/3	+ ev	8.0	0.04
Outside Soil - Layer 2	2.37	60.9	28.3	10.8	very gravelly sandy loam	14.4	19.7	13.1	26.7	26.1	5.32	36.2	7.5YR7/4	7.5YR5/4	+ ev	8.1	0.05
‡ Slivovitz - Outside Soil	4.83	61.7	23.0	15.3	gravelly sandy loam	29.9	25.0	11.6	17.6	15.8	9.07	33.9	10YR3/1	10YR2/1	-	6.8	0.17
Coal Valley Dry Lake Sediment Sample	1.42	36.1	18.8	45.1	clay	0.1	4.7	14.6	48.7	32.0	4.97	0.0	10YR7/2	10YR6/3.5	+ ev	8.0	0.04

Figure 1: Textural Classification of Samples

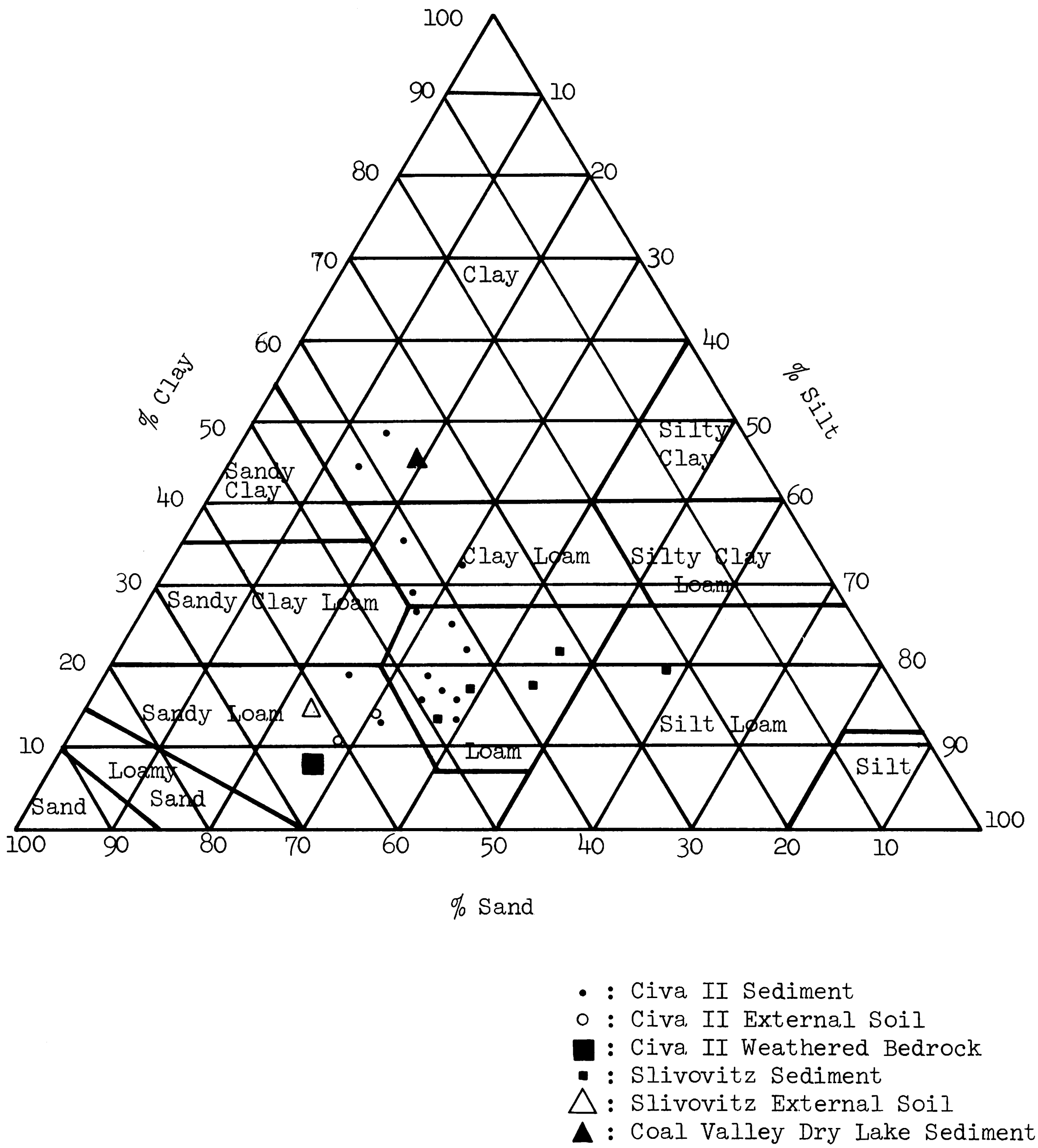


Figure 2

Slivovitz Shelter - Sand Fraction Distribution

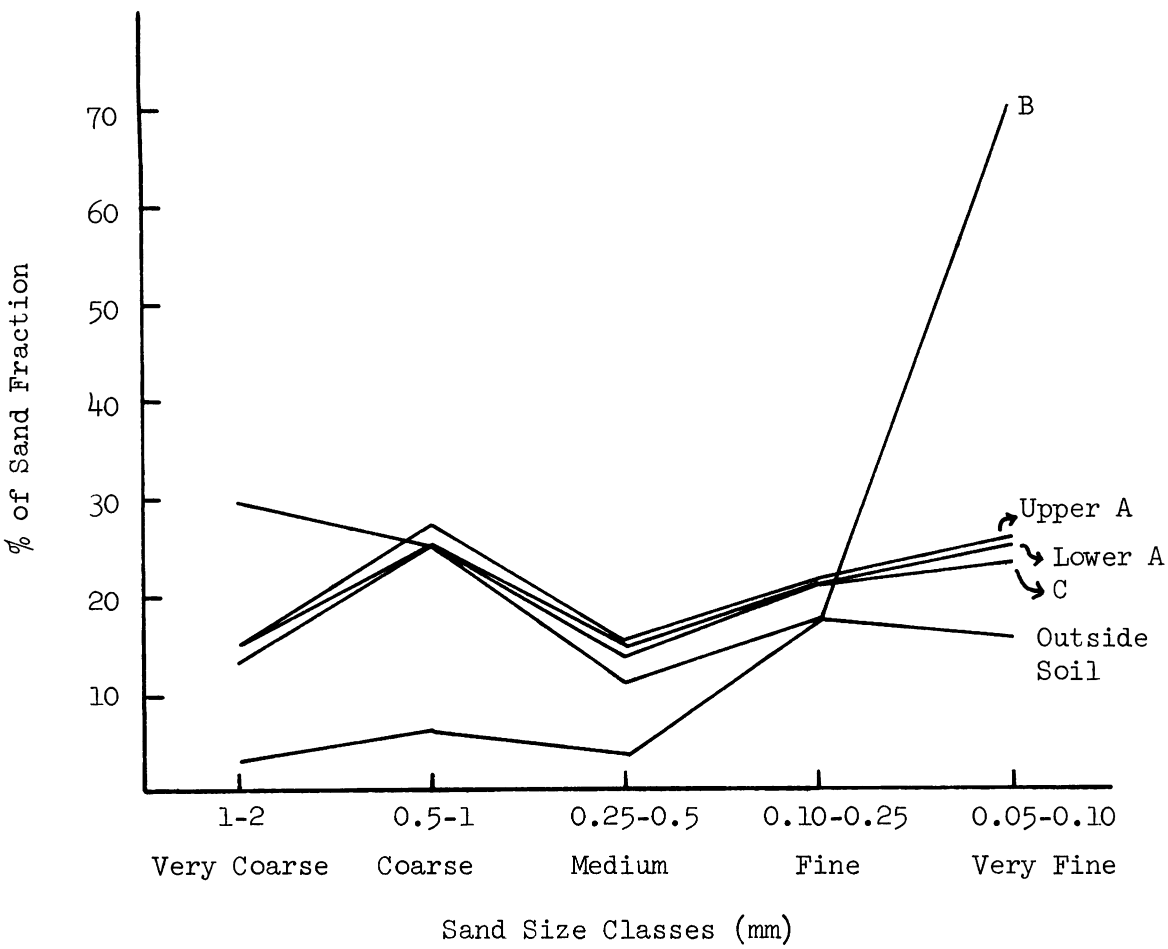
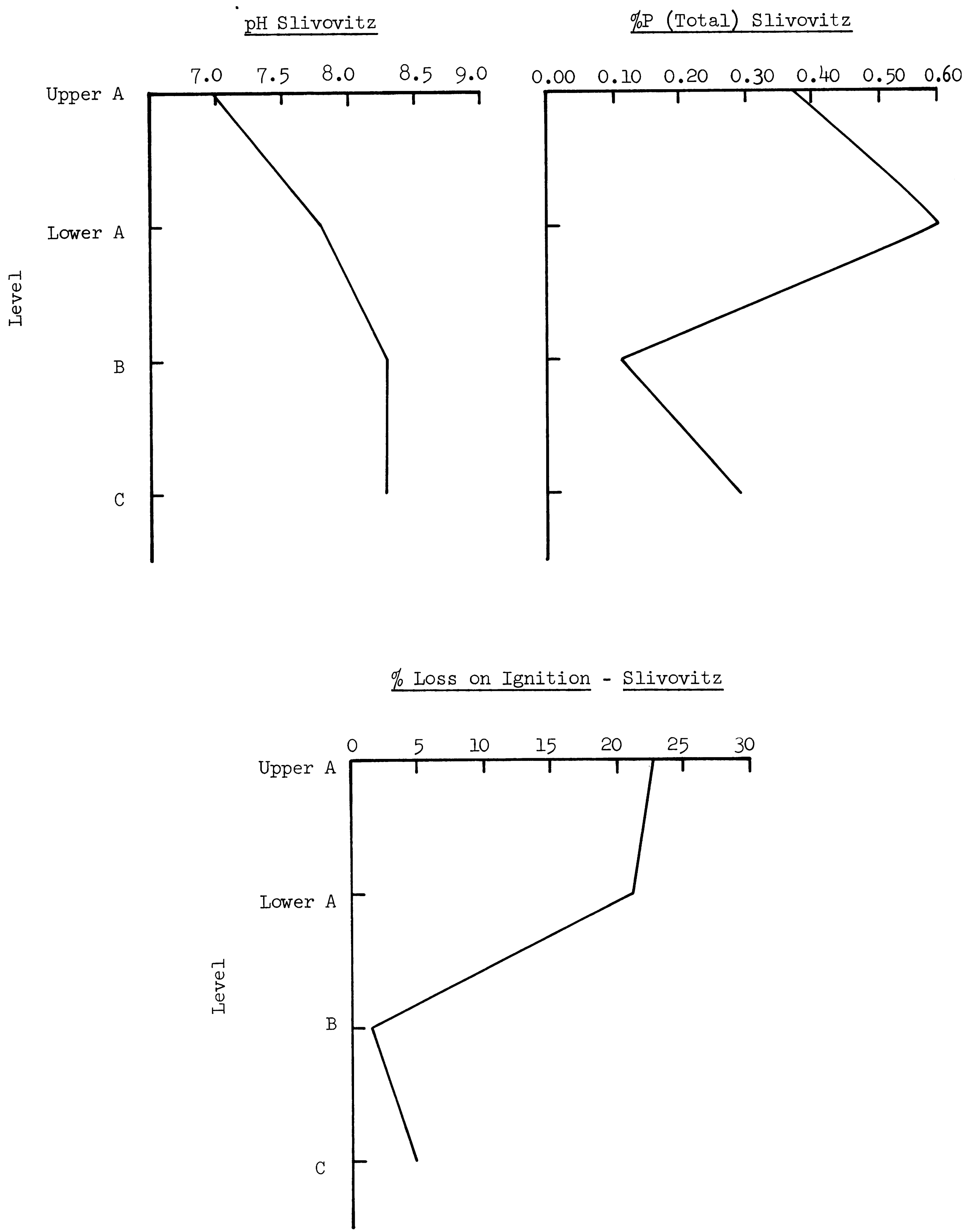


Figure 3


pH Slivovitz
7.0
7.5
8.0
8.5
9.0
%P (Total) Slivovitz
0.00
0.10
0.20
0.30
0.40
0.50
0.60
Upper A
Lower A
B
C
Level
% Loss on Ignition - Slivovitz
0
5
10
15
20
25
30
Upper A
Lower A
B
C
Level

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